C-3103

Log Data Report

Borehole Information:

Borehole: C-3103			Site: 216-B-7A Crib		
Coordinates (Plant)		GWL[1] (ft):	n/a[2]	GWL Date:	n/a
North	East	Drill Date	TOC[3] Elevation	Total Depth (ft)	Type
137385.743	573803.238	09/01	199.049	219.0	cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel (threaded)	1.0	6.625	5.625	0.5	0	56.5
Steel (threaded)	0.7	11.75	10.75	0.5	0	50.75
Steel (threaded)	1.4	8.75	7.75	0.5	0	130.5
Steel (threaded)	3.5	6.625	5.625	0.5	0	218.0

Borehole Notes:

The casing depth information provided above is derived from personal communication with the Bechtel Hanford Incorporated site representative. The casing size information is derived from caliper measurements collected in the field by MACTEC-ERS personnel. Logging measurements are referenced to ground surface. The original 6-in. casing in place from 0 to 56.5 ft was removed and replaced with the 11-in. casing from 0 to 50.75 ft. Drilling was stopped at about 220 ft where perched groundwater was encountered.

Logging Equipment Information:

Logging System:	Gamma 1C		Type: HRLS
Calibration Date:	09/00	Calibration Reference:	GJO-2001-244-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	Gamma 1D		Type: SGLS (35%)
Calibration Date:	07/01	Calibration Reference:	GJO-2001-243-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	Gamma 2A		Type: SGLS (35%)
Calibration Date:	09/00	Calibration Reference:	GJO-2001-246-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	Gamma 2B		Type: SGLS (35%)
Calibration Date:	09/00	Calibration Reference:	GJO-2001-245-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	Gamma 2E		Type: NMLS
Calibration Date:	05/01	Calibration Reference:	GJO-2001-247-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: Moisture
Calibration Date:	07/01	Calibration Reference:	RLSM00.0 (Randall 2001)
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4 (Repeat)	5
Date	08/29/01	08/29/01	08/29/01	08/29/01	09/24/01
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth	2.0	19.0	36.5	55.0	54.0
Finish Depth	18.5	36.0	55.5	49.0	130.5
Count Time (sec)	200	30	200	200	200
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.5	0.5	0.5	0.5	0.5
ft/min	n/a	n/a	n/a	n/a	n/a
Pre-Verification	B0041CAB	B0041CAB	B0041CAB	B0041CAB	B0057CAB
Start File	B0042000	B0042034	B0042069	B0042108	B0057000
Finish File	B0042033	B0042068	B0042107	B0042120	B0057153
Post-Verification	B0042CAA	B0042CAA	B0042CAA	B0042CAA	B0057CAA

Log Run	6 (Repeat)	7	8	9 (Repeat)	
Date	09/24/01	09/27/01	09/27/01	09/27/01	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth	130.5	129.0	147.0	218.5	
Finish Depth	122.5	148.0	218.5	209.5	
Count Time (sec)	200	200	200	200	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	0.5	0.5	0.5	0.5	
ft/min	n/a	n/a	n/a	n/a	
Pre-Verification	B0057CAB	A0003CAB	A0003CAB	A0003CAB	
Start File	B0057154	A0003000	A0003039	A0003183	
Finish File	B0057170	A0003038	A0003182	A0003201	
Post-Verification	B0057CAA	A0003CAA	A0003CAA	A0003CAA	

High Rate Logging System (HRLS) Log Run Information:

Log Run	10	11 (Repeat)	12		
Date	08/30/01	08/30/01	08/30/01		
Logging Engineer	Musial	Musial	Musial		
Start Depth	17.5	37.0	24.0		
Finish Depth	37.0	33.0	22.0		
Count Time (sec)	300	300	1200		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	0.5	0.5	1.0		
ft/min	n/a	n/a	n/a		
Pre-Verification	D0004CAB	D0004CAB	D0004CAB		
Start File	D0004000	D0004040	D0004049		

Log Run	10	11 (Repeat)	12		
Finish File	D0004039	D0004048	D0004051		
Post-Verification	D0004CAA	D0004CAA	D0004CAA		

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	13	14 (Repeat)	15	16 (Repeat)	
Date	08/29/01	08/29/01	09/24/01	09/24/01	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth	3.5	55.25	54.0	130.5	
Finish Depth	55.55	49.73	130.5	122.5	
Count Time (sec)	n/a	n/a	15	15	
Live/Real	n/a	n/a	L	L	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	n/a	n/a	0.25	0.25	
ft/min	1.0	1.0	n/a	n/a	
Pre-Verification	C0013CAB	C0013CAB	C0018CAB	C0018CAB	
Start File	C0013000	C0013213	C0018000	C0018307	
Finish File	C0013212	C0013235	C0018306	C0018339	
Post-Verification	C0013CAA	C0013CAA	C0018CAA	C0018CAA	

Radionuclide Logging System (RLS) Moisture Log Run Information:

Log Run	17	18 (Repeat)			
Date	09/27/01	09/27/01			
Logging Engineer	Spatz	Spatz			
Start Depth	128.0	219.0			
Finish Depth	219.0	210.0			
Count Time (sec)	n/a	n/a			
Live/Real	n/a	n/a			
Shield (Y/N)	N	N			
MSA Interval (ft)	n/a	n/a			
ft/min	1.0	1.0			
Pre-Verification	C0192CAB	C0192CAB			
Start File	C0192000	C0192365			
Finish File	C0192364	C0192401			
Post-Verification	C0192CAA	C0192CAA			

Logging Operation Notes:

SGLS, HRLS, NMLS, and RLS logging were performed in this borehole between August and September 2001 on three separate days. The logging occurred inside three different casing configurations as the borehole was drilled. A longer count time (200 sec) than usual (100 sec) was required with the SGLS because of the relatively thick casing and to possibly detect plutonium that was thought to exist in the area. The HRLS was utilized to collect data in a high gamma flux zone between 17.5 and 37 ft where high SGLS dead times were encountered. In addition, test spectra were collected with the HRLS between 22 and 24 ft using a 1,200 second counting time. Because the HRLS planar detector is more sensitive to lower energy gamma photons than high-energy photons, it was believed low-yield plutonium-239 (^{239}Pu) energy peaks between about 59 and 414 keV might be observed in the spectra. Neutron moisture log data were also collected in this borehole. Data repeat sections for each logging system were collected to measure the systems' performance.

Analysis Notes:

Analyst:	Henwood	Date:	10/16/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Pre-run and post-run verifications of the logging tools were performed for each day's log event. Acceptance criteria were met for the SGLS and HRLS. The post-verification spectra were used for the energy and resolution calibration for the data processing.

Verification measurements were also collected for the NMLS and RLS moisture systems. Acceptance criteria have not yet been established for the logging systems. However, the pre- and post-run total count rate measurements agree within about 5%, suggesting the logging systems were operating properly during data collection.

Each spectrum collected during a log run was processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL using an efficiency function and corrections for casing as appropriate. Dead time corrections are applied to log data, including the total gamma data, where the dead time is in excess of 10 percent. In zones of high dead time (> 40%) gross count rates and radionuclide concentrations are not considered reliable, and may be significantly higher than the reported values. The HRLS is utilized when high dead times are encountered. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations rather than the ^{214}Bi peak at 609 keV. The 609-keV energy peak cannot be distinguished as a result of interference from the ^{137}Cs peak at 662 keV in higher concentration zones.

For the neutron moisture logs, calibration functions are available for 6-in. and 8-in.-diameter boreholes with conventional ASTM schedule-40 steel casing. The calibration function converts total neutron count rate to volume percent moisture content. Neutron moisture data from the interval between 54 and 130.5 ft were analyzed using the calibration function for an 8-in. borehole. Neutron moisture data from the intervals between 3.5 and 55.5 ft and 128 and 219 ft were analyzed using the calibration function for a 6-in. borehole. A correction factor developed from data provided by Meisner, Price, and Randall (WHC-SD-EN-TI-306) was applied to the data in the 8-in. interval to account for the 0.5-in. casing thickness. This factor increased the calculated moisture content by approximately 17 percent. No such correction factor was available for a 6-in. borehole; therefore, the same correction factor was also applied over depth intervals where a 6-in., 0.5-in.-thick casing was present.

Repeat log plots at selected depth intervals for spectral gamma concentrations and neutron moisture measurements were evaluated. The spectral gamma plots indicate good agreement between successive log runs, demonstrating repeatability in both depth and concentration measurement. The moisture plots also indicate good agreement for log data collected within the same casing configuration. Repeatability of calculated volumetric moisture content is not good in depth intervals where log data were collected in different sized casings (e.g., see moisture repeat section from 50 to 55 ft). As noted above, the correction applied to the 6-in. casing is the same as that applied to the 8-in. casing even though a correction for 6-in. casing has not been experimentally derived. It appears this casing thickness correction causes an overestimation of the volumetric moisture in 6-in. boreholes, particularly where the moisture content is less than 5 percent by volume; calibration data are not collected for curve fitting between zero and 5 percent moisture.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{137}Cs and ^{154}Eu), naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U [KUT]), a combination of man-made, KUT, total gamma and moisture, total gamma plotted with dead time, and repeat section plots for spectral gamma and moisture measurements. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. These errors are discussed in the calibration report.

Results and Interpretations:

The man-made radionuclides detected in this borehole were ^{137}Cs and ^{154}Eu. ^{137}Cs is detected continuously from near the ground surface to about 56 ft in depth with the highest concentration of about 300,000 pCi/g measured at about 23 ft. ^{154}Eu is detected between 16 and 18 ft and probably exists at some depth intervals within the high rate zone between 18 and 27 ft. The HRLS detector is less efficient than the SGLS in detecting higher energy peaks such as the 1274-keV ^{154}Eu peak. No other man-made radionuclide was detected in this borehole, including ^{239}Pu, for which longer counting times were employed to enhance the possibility of detection.

SGLS measurements were collected between 54 and 55.5 ft in both log run 3 and log run 5 (see man-made radionuclide plot). A 6-in. casing was in place at this depth interval during log run 3. When log data were collected during log run 5, the original 6-in. casing had been removed and an 8-in. casing existed in the depth interval. The calculated ^{137}Cs concentrations from log run 5 were much lower than in log run 3. The discrepancy in concentrations between the two log runs suggests contaminated material had been dragged down from the high-rate interval to lower depths during the drilling process or the original casing was contaminated. Once the casing was removed and the borehole was drilled to a larger diameter, the ^{137}Cs concentrations measured about 1 pCi/g. Most of the ^{137}Cs contamination measured during log run 3 below about 43 ft is likely the result of borehole contamination.

The KUT logs do not delineate any definitive lithologic units. Changes in the ^{40}K concentrations from about 12 pCi/g at about 18 ft to about 17 pCi/g near 37 ft suggest a lithologic change occurs in the high rate interval. A thin bed with relatively high ^{232}Th concentrations occurs at about 107 ft and may be useful to correlate in nearby boreholes.

Relatively higher moisture content appears to exist in the interval from 18 to 37 ft. The highest moisture content occurs at 20 ft in depth, just above the depth where the highest ^{137}Cs concentrations were measured. An interval between about 80 and 100 ft indicates slightly higher moisture that corresponds with finer grained soil as indicated by slightly higher concentrations of ^{40}K and ^{232}Th. The remainder of the borehole exhibits consistent moisture content in the soils. The moisture content is increasing near the bottom of the borehole and the final data point at 218 ft indicates the detector is in close proximity to groundwater but has not fully entered the saturated interval.

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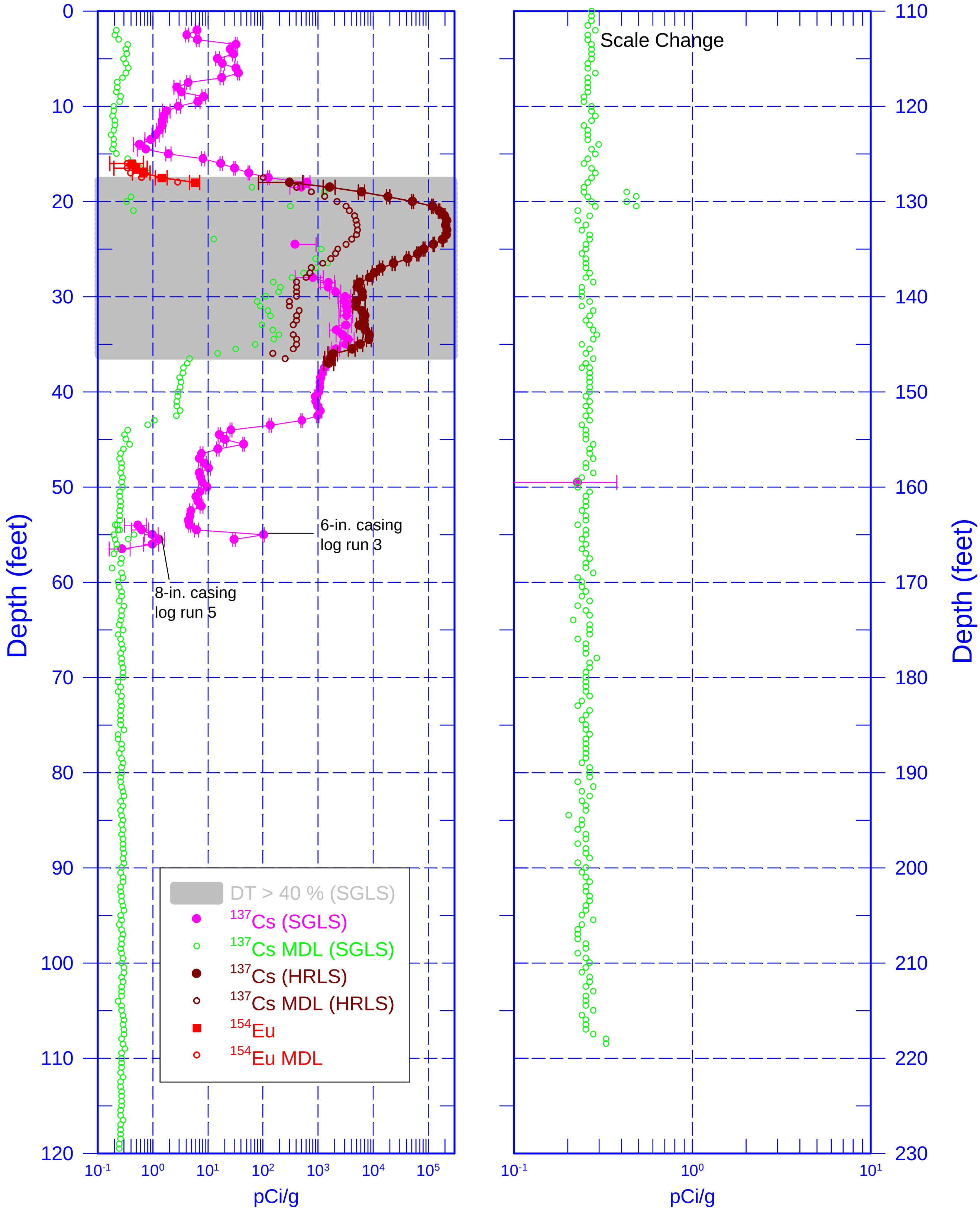
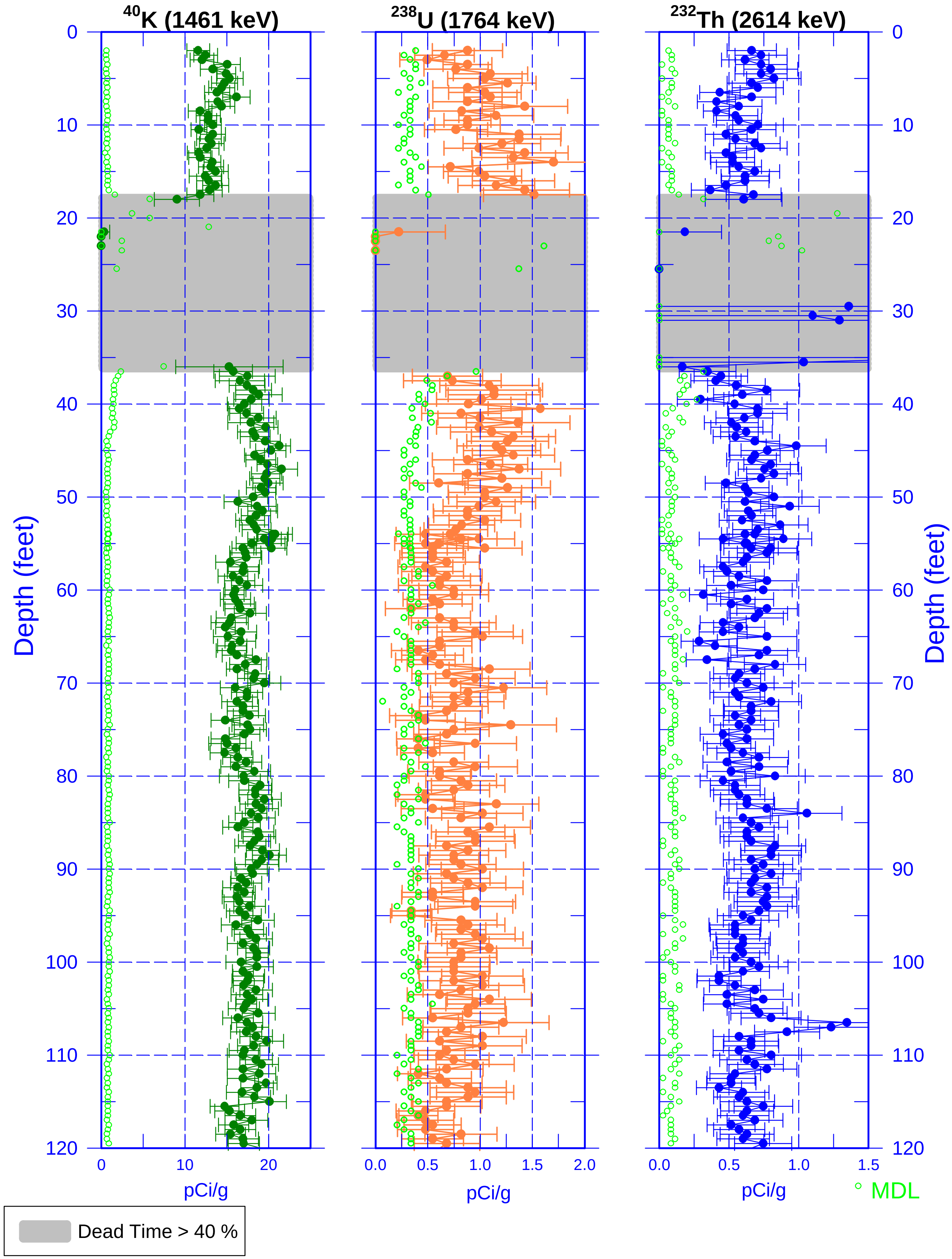
[1] GWL – groundwater level
[2] n/a – not applicable
[3] TOC – top of casing

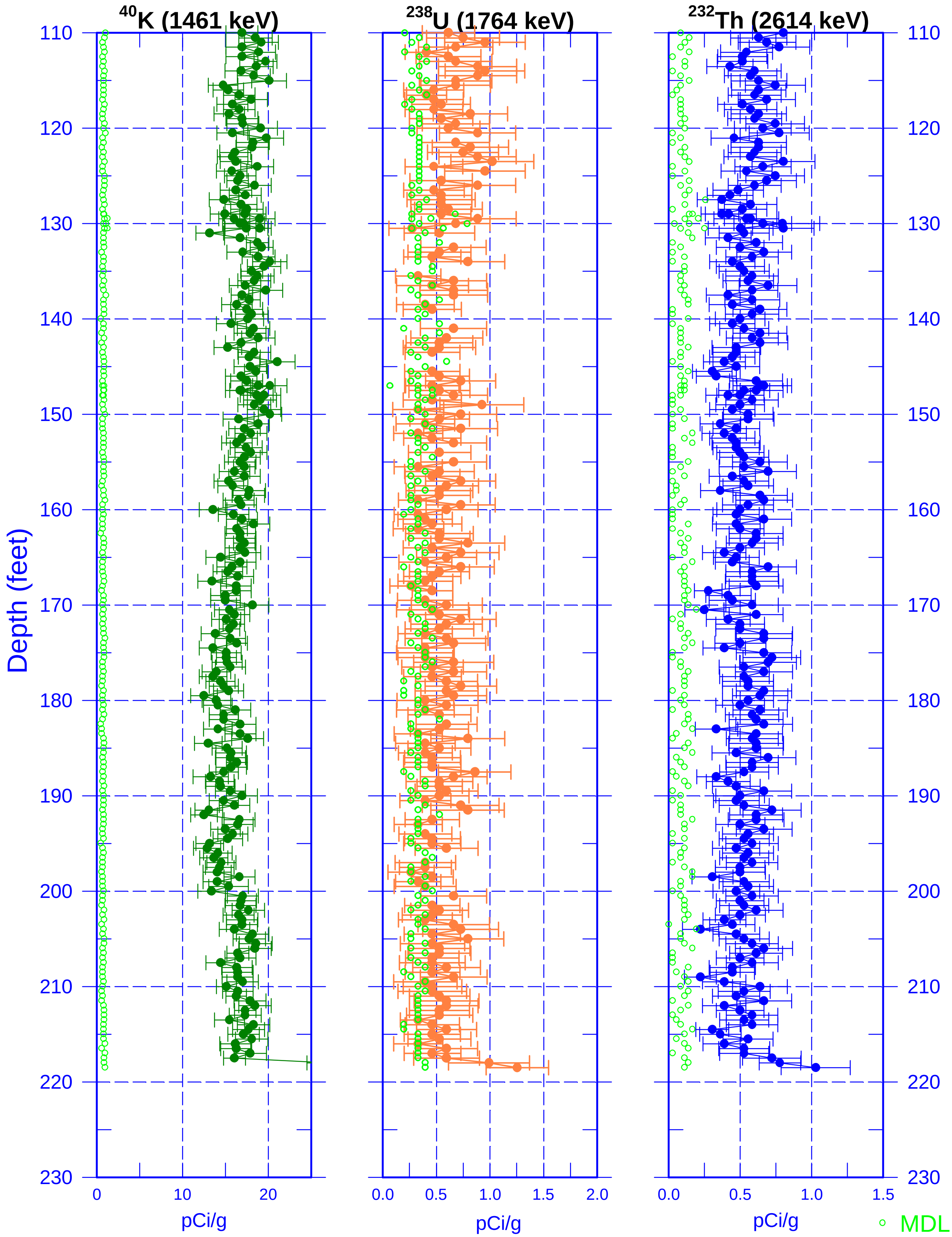
C-3103
Man-Made Radionuclide Concentrations



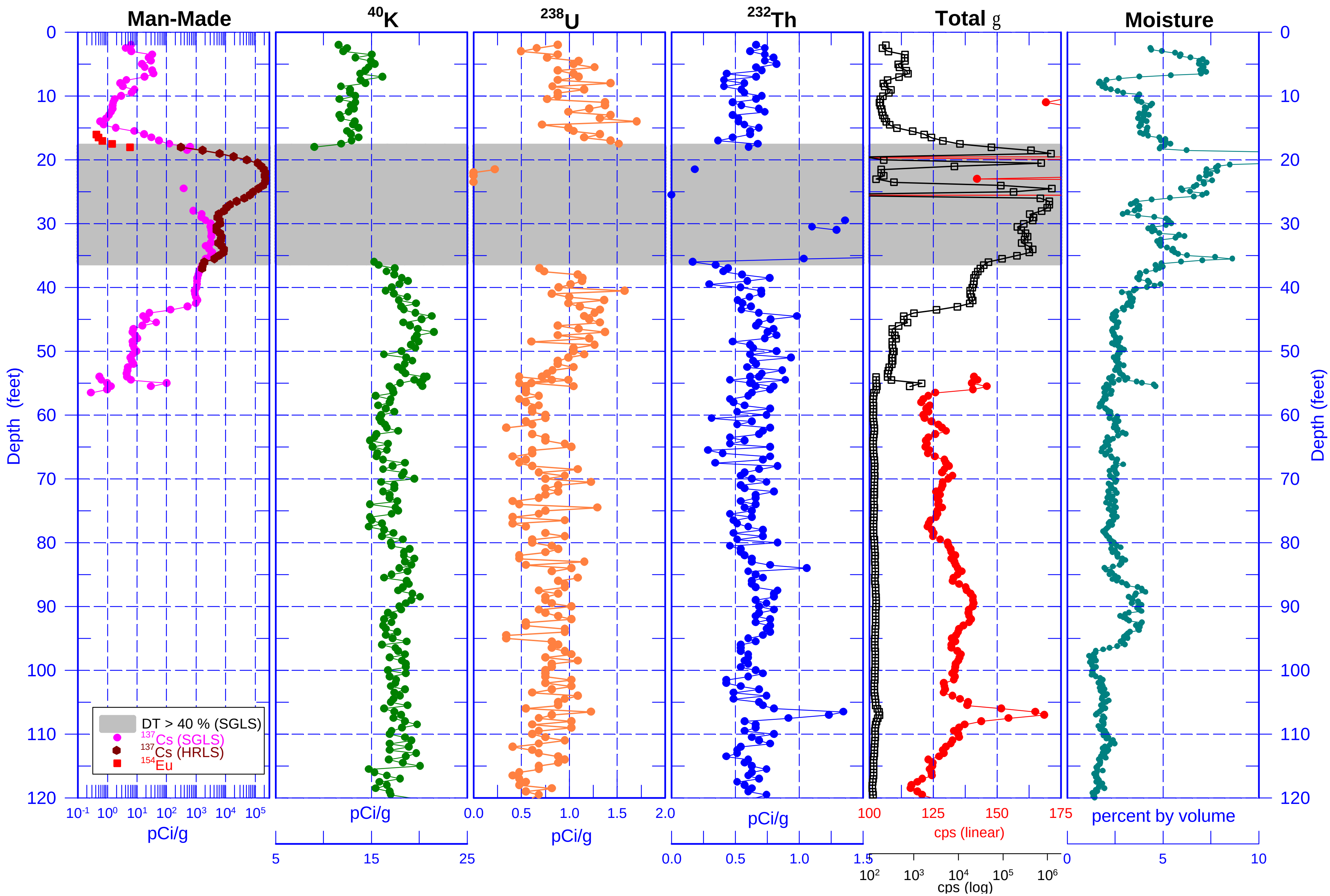
C-3103
Natural Gamma Logs



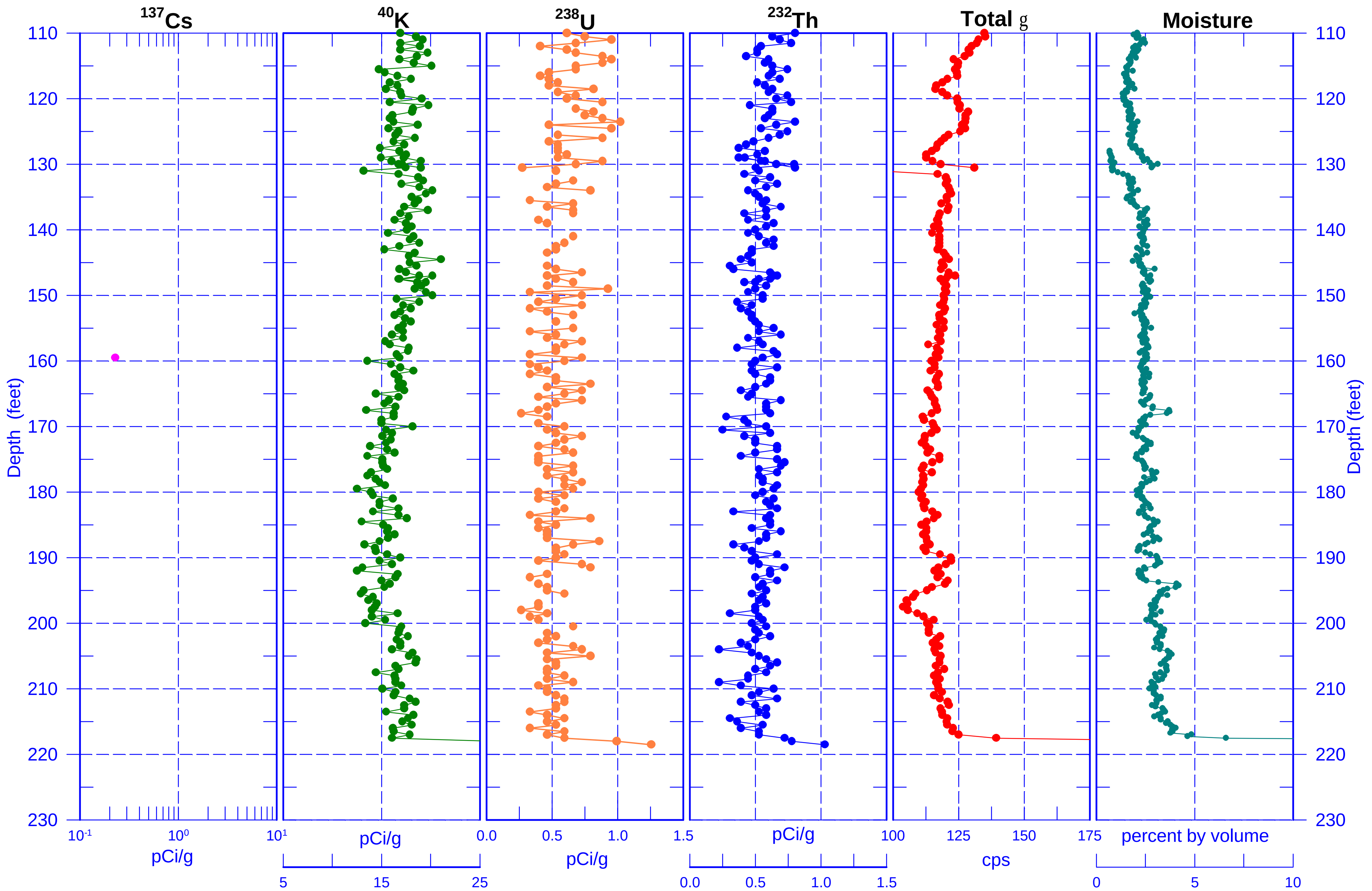
C-3103
Natural Gamma Logs



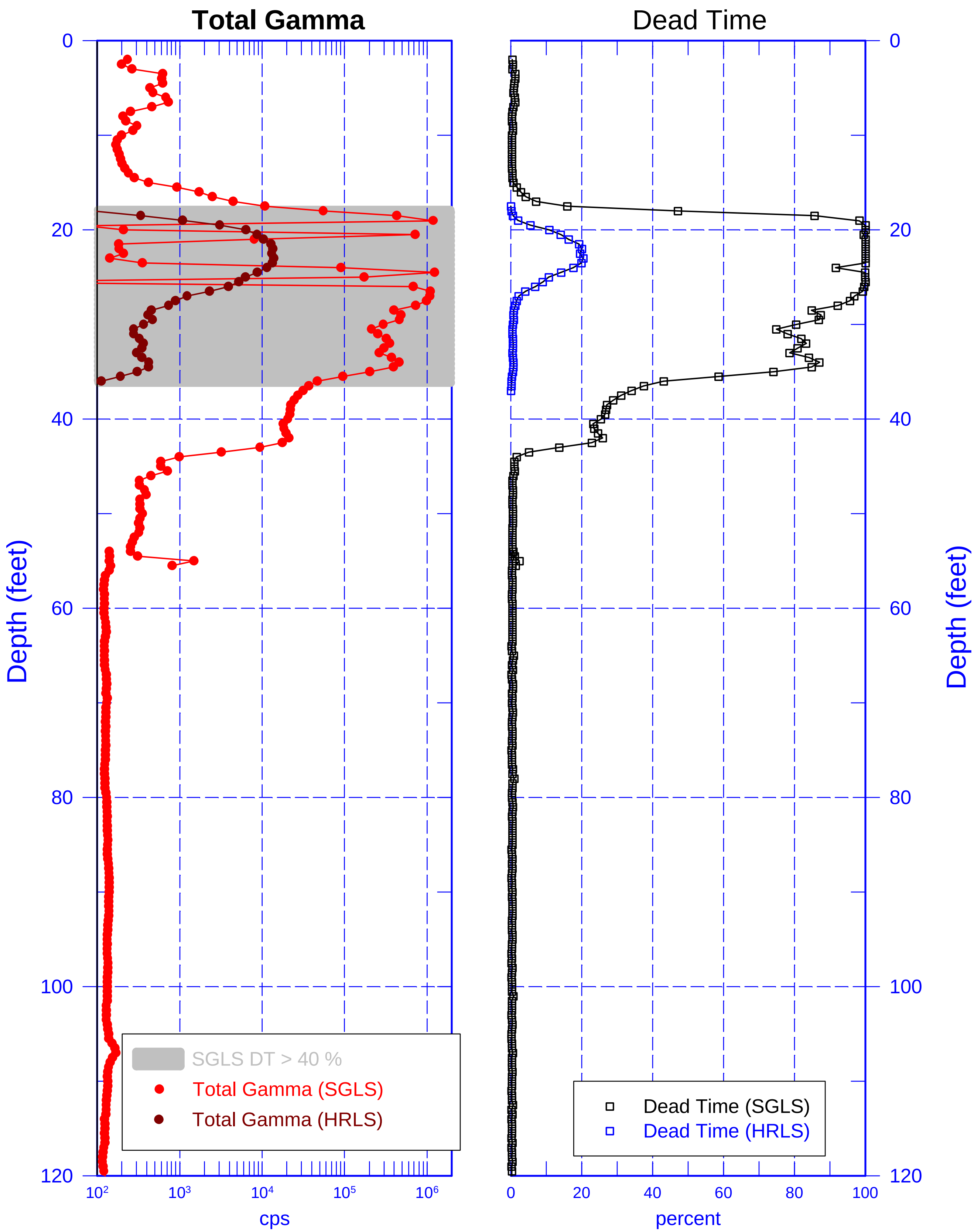
C-3103 Combination Plot



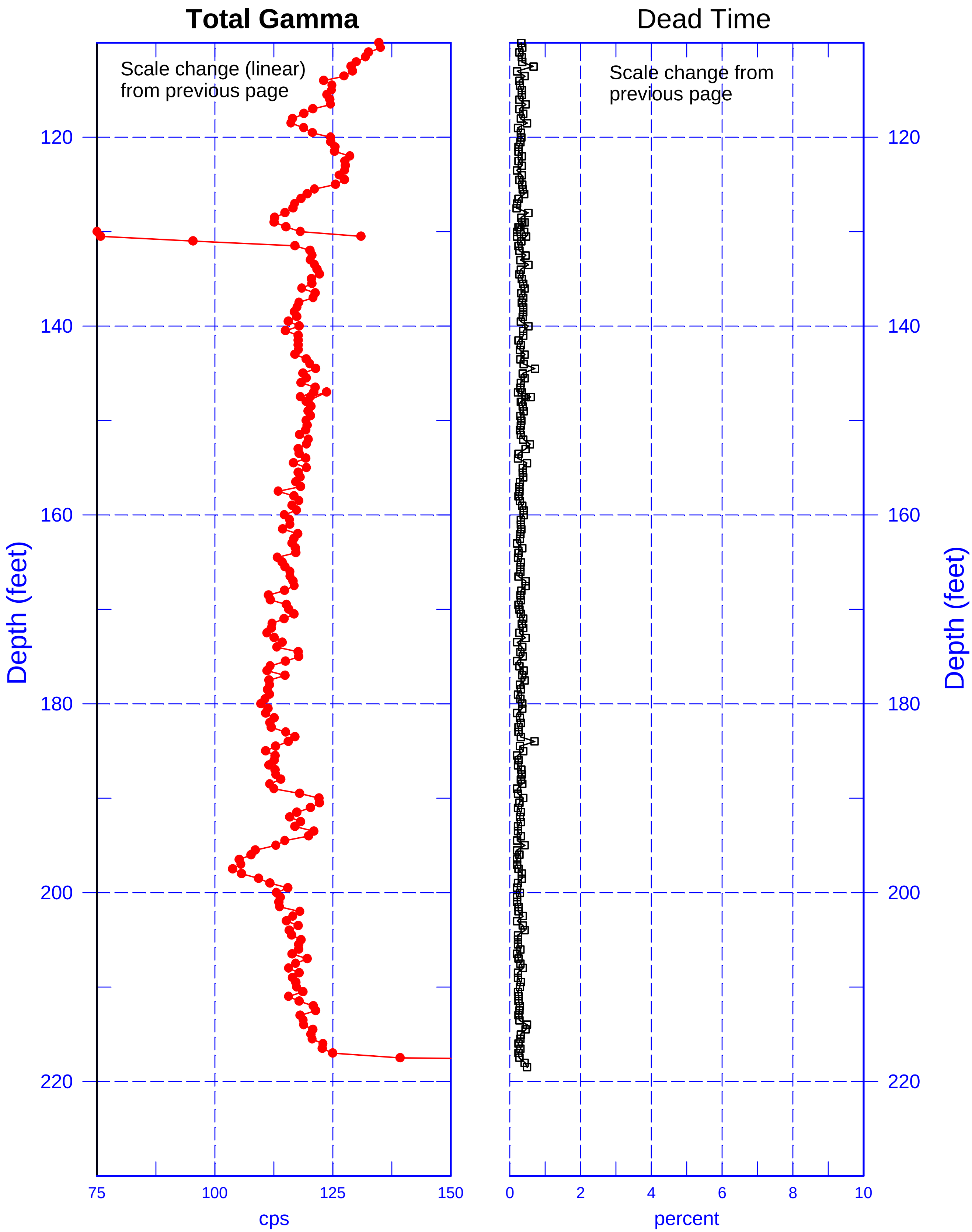
C-3103 Combination Plot (continued)



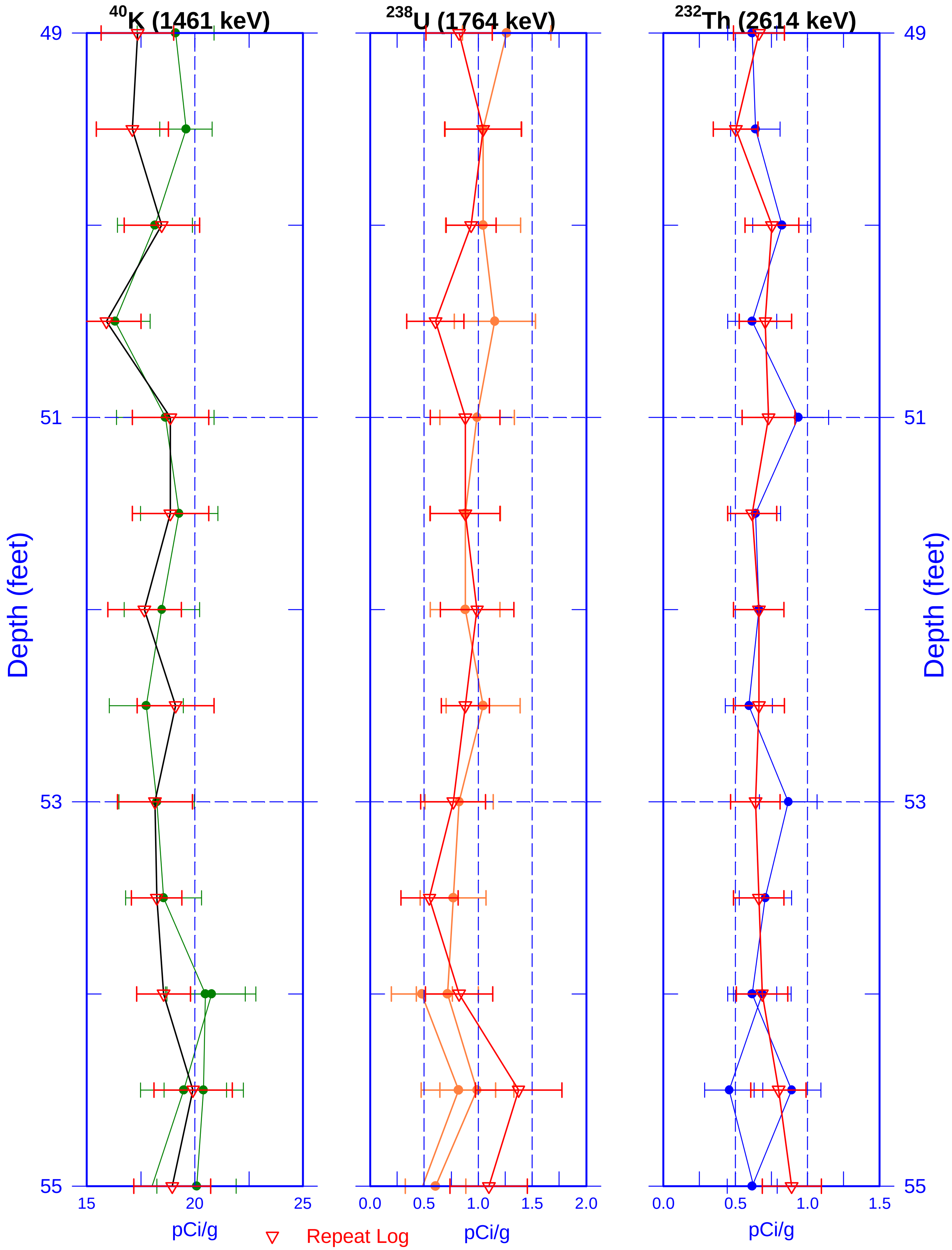
C-3103


Total Gamma
Dead Time
Depth (feet)
Depth (feet)
0
20
40
60
80
100
120
10^2
10^3
10^4
10^5
10^6
cps
0
20
40
60
80
100
percent
SGLS DT > 40 %
Total Gamma (SGLS)
Total Gamma (HRLS)
Dead Time (SGLS)
Dead Time (HRLS)

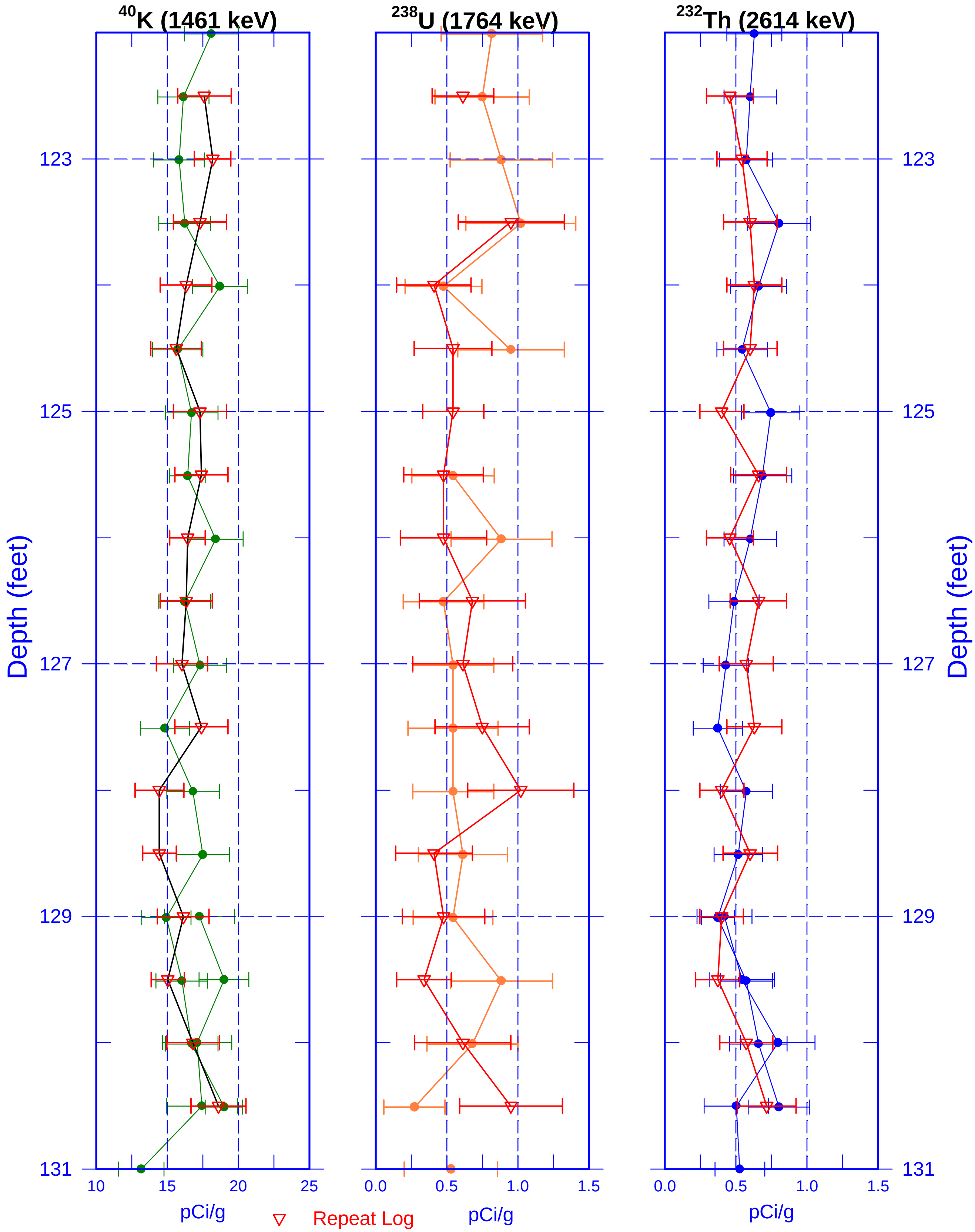
C-3103 (continued)



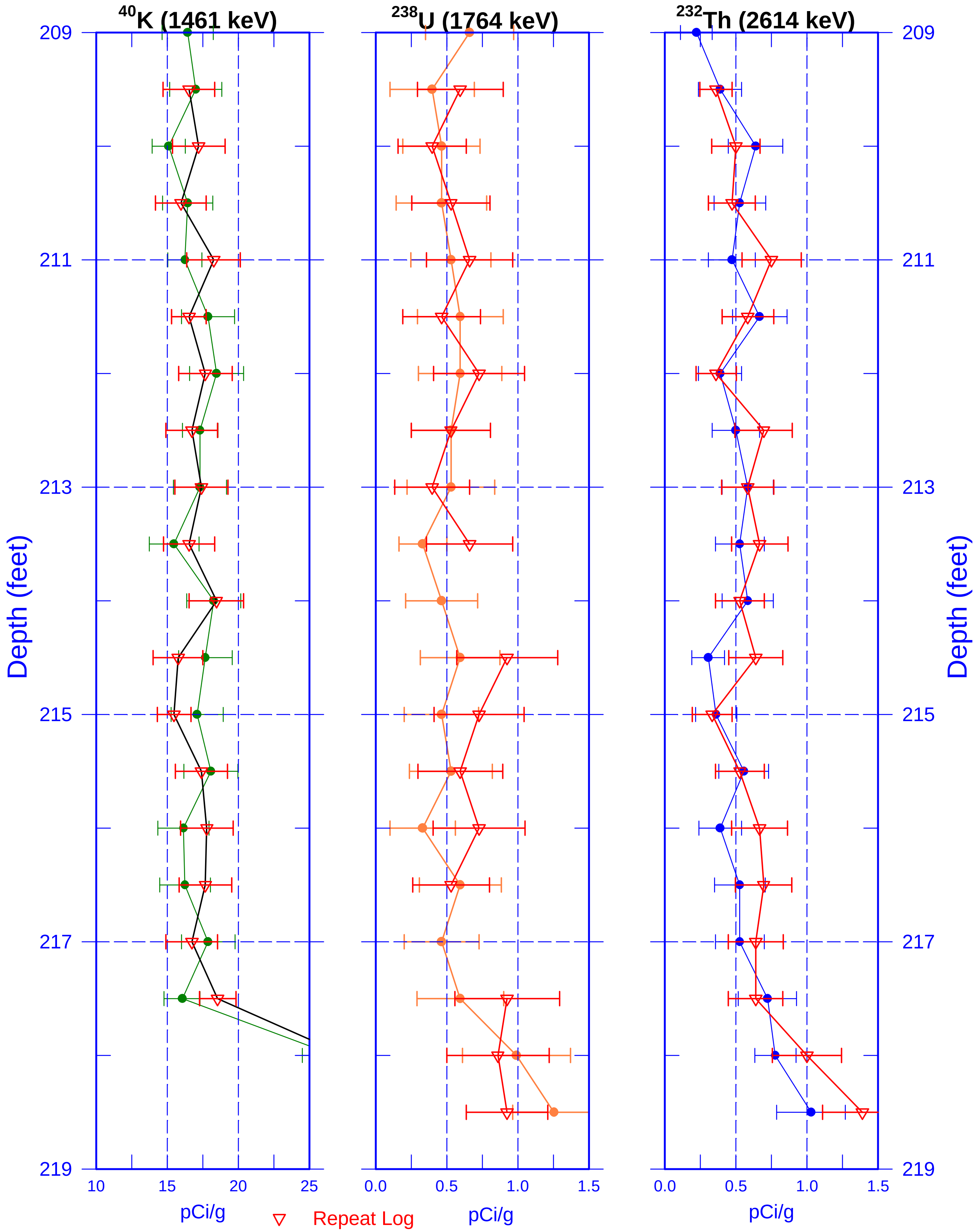
C-3103
Natural Gamma Logs (Repeat)



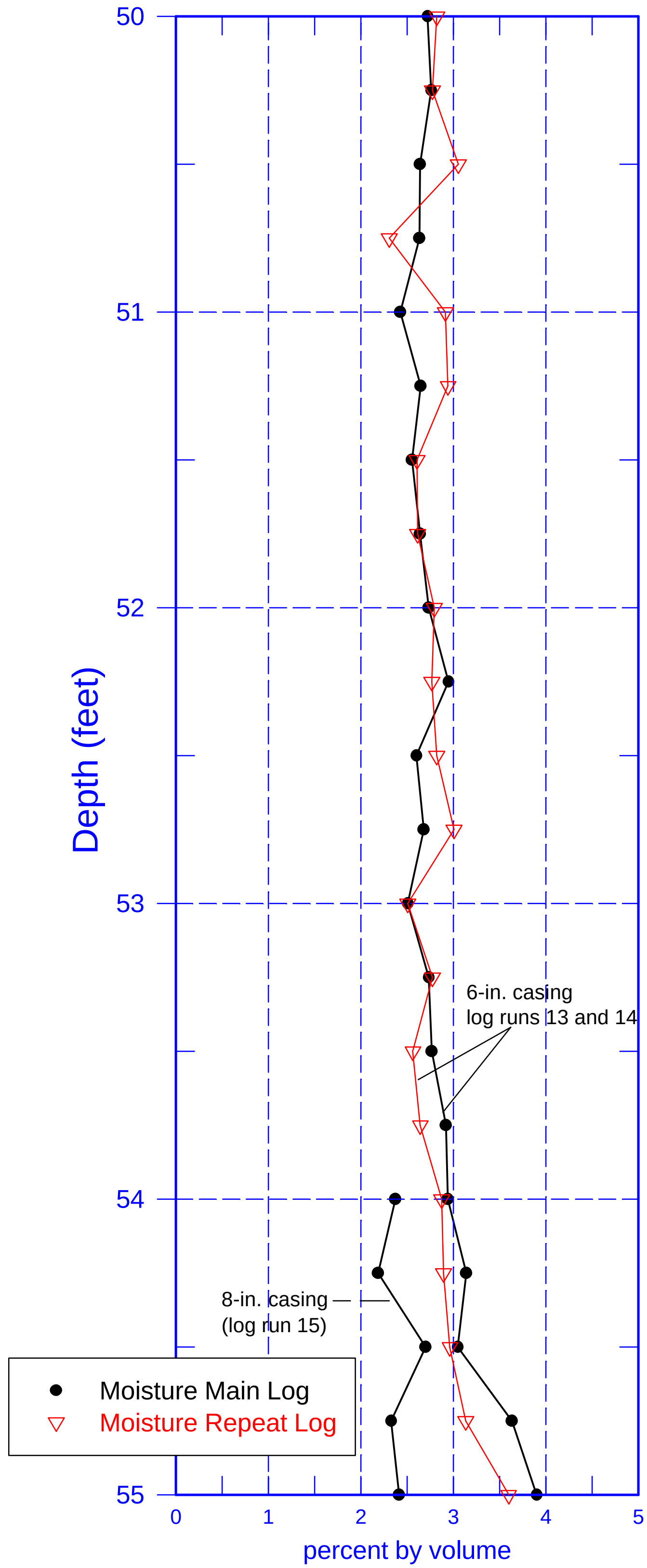
C-3103
Natural Gamma Logs (Repeat)



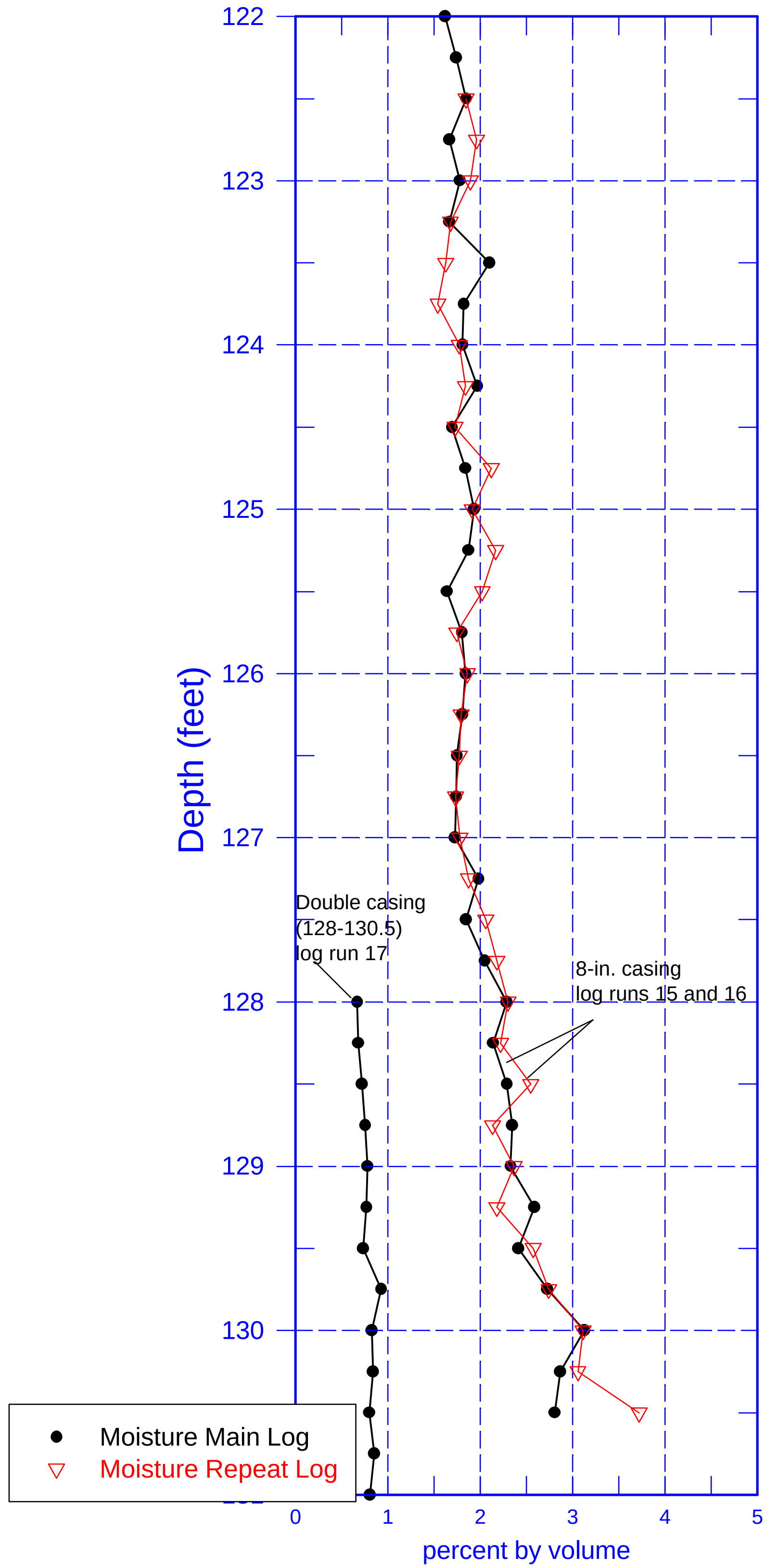
C-3103
Natural Gamma Logs (Repeat)



C-3103
Moisture Repeat Section



C-3103
Moisture Repeat Section



C-3103
Moisture Repeat Section